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- I. Model Problems.
- II. Practice
- III. Challenge Problems
- IV. Answer Key

## Web Resources

### Dividing Complex Numbers

[www.mathwarehouse.com/algebra/complex-number/divide/how-to-divide-complex-numbers.php](http://www.mathwarehouse.com/algebra/complex-number/divide/how-to-divide-complex-numbers.php)



Complex Number Calculator

[www.mathworksheetsgo.com/algebra-calculators/complex-number-calculator.php](http://www.mathworksheetsgo.com/algebra-calculators/complex-number-calculator.php)

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Online Graphing Calculator(free): <http://www.meta-calculator.com/online/>

## Complex Conjugates

Recall:  $(a-b)(a+b) = a^2 - b^2$

The conjugate of  $a + bi = a - bi$

### I. Model Problems

In these examples we will find the conjugate.

**Example 1:  $-7i$**

The sign of the imaginary part of the complex number changes.

**Answer:  $7i$**

Original number:  $-7i$

Conjugate:  $7i$

**Example 2:  $3 + 9i$**

The sign of the imaginary part of the complex number changes.

**Answer:  $3 - 9i$**

Original number:  $3 + 9i$

Conjugate:  $3 - 9i$

In this examples we will rationalize the denominator.

**Example 3:  $\frac{5}{2+7i}$**

Find the conjugate of the denominator.

Multiply by a convenient form of 1 with conjugates.

Simplify. Recall  $i^2 = -1$

Original number:  $2 + 7i$

Conjugate:  $2 - 7i$

$$\begin{array}{r} \frac{(5)}{(2+7i)} \cdot \frac{(2-7i)}{(2-7i)} \\ \frac{(5)(2-7i)}{(2+7i)(2-7i)} \\ \frac{10-35i}{4-49i^2} \\ \frac{10-35i}{4-49(-1)} \\ \frac{10-35i}{4+49} \\ \frac{10-35i}{53} \end{array}$$

**Answer:  $\frac{10-35i}{53}$**

## II. Practice Problems

Find the conjugate.

1.  $4i$

2.  $-1.6i$

3.  $3 - i$

4.  $4 + 2i$

5.  $-5 - 2i$

6.  $-18 + 4i$

Simplify completely.

7.  $\frac{2}{5i}$

8.  $\frac{3}{-4i}$

9.  $\frac{-2}{3i}$

10.  $\frac{7}{5i}$

11.  $\frac{4-2i}{3i}$

12.  $\frac{5-4i}{2i}$

13.  $\frac{7-3i}{8i}$

14.  $\frac{3+i}{2-i}$

15.  $\frac{3-2i}{4+3i}$

16.  $\frac{7-8i}{7+8i}$

17.  $\frac{5-3i}{6+2i}$

18.  $\frac{11-2i}{2-11i}$

19.  $\frac{4i}{5-2i}$

20.  $\frac{12-10i}{3+5i}$

21.  $\frac{3-2i}{3+2i}$

22.  $\frac{3-2i}{2i-3}$

## III. Challenge Problems

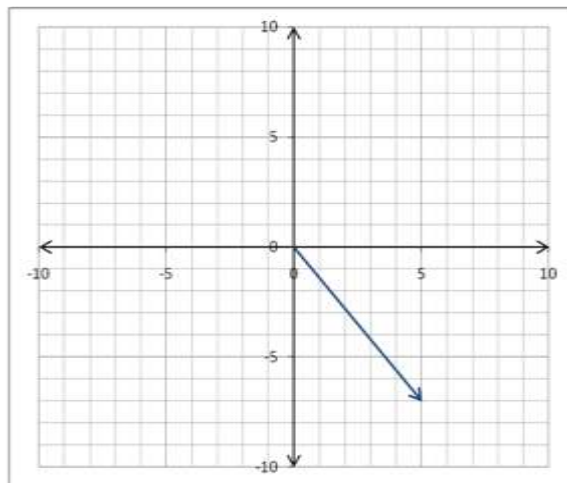
1. Find the student's error  $\frac{3}{-5-2i} \cdot \frac{(5+2i)}{(5+2i)} = \frac{15+6i}{-25-20i-4i^2} = \frac{15+6i}{-25-20i-4(-1)} = \frac{15+6i}{-21-20i}$

2. How is rationalizing a rational expression with a radical in the denominator similar to rationalizing a rational expression with a complex number in the denominator?

3. Find a quadratic equation with real coefficients with a root of  $4 - 5i$ ?

4. Simplify  $\frac{a - bi}{bi - a}$

5. This is the graph of  $5 - 7i$ . Graph its conjugate.



#### IV. Answer Key

1.  $-4i$

2.  $1.6i$

3.  $3 + i$

4.  $4 - 2i$

5.  $-5 + 2i$

6.  $-18 - 4i$

7.  $\frac{-2i}{5}$

8.  $\frac{3i}{4}$

9.  $\frac{2i}{3}$

10.  $-\frac{7i}{5}$

11.  $\frac{-2-4i}{3}$

12.  $\frac{-4-5i}{2}$

13.  $\frac{-3-7i}{8}$

14.  $1 + i$

15.  $\frac{6-17i}{25}$

16.  $\frac{-15-112i}{113}$

17.  $\frac{6-7i}{10}$

18.  $\frac{44+117i}{125}$

19.  $\frac{-8+20i}{29}$

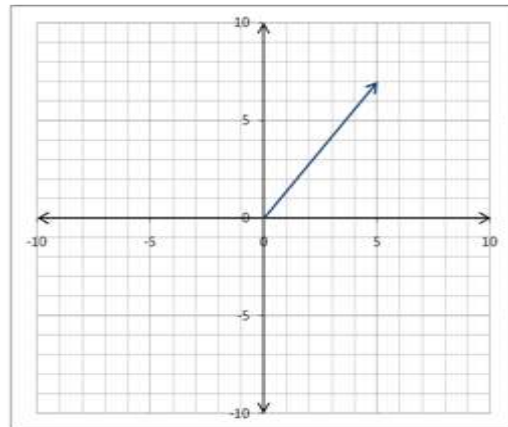
20.  $\frac{-7-45i}{18}$

21.  $\left(\frac{3-2i}{3+2i}\right)\left(\frac{3-2i}{3-2i}\right) = \frac{9-6i-6i+4i^2}{9-6i+6i-4i^2}$   
 $\frac{9-12i-4}{9+4} = \frac{5-12i}{13}$

22.  $\left(\frac{3-2i}{2i-3}\right)\left(\frac{2i+3}{2i+3}\right) = \frac{6i+9-4i^2-6i}{4i^2+6i-6i-9}$   
 $\frac{9+4}{-4-9} = \frac{13}{-13} = -1$

#### Challenge Problems

1. Conjugate of  $-5 - 2i$  is  $-5 + 2i$ , only the sign of the imaginary part of the complex number changes.
2. You use conjugates to rationalize both.
3.  $x^2 - 8x + 41$
4. -1 . Consult question #22 to see a specific example
5. See graph:



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